Chapter 3

Hydrology and Water Supply

Chapter 3. Hydrology and Water Supply

INTRODUCTION

This chapter provides supplemental modeling results for evaluating the hydrologic effects of the new alternatives with Reclamation's PROSIM hydrologic simulation model. Since publication of the 1997 DEIR/EIS, Reclamation updated PROSIM, incorporating revisions to CVP operating conditions and several program logic functions. PROSIM was updated to facilitate the iterative use of a monthly time series of EBMUD demands generated by the EBMUDSIM model. The model's simulation of EBMUD deliveries from the American River basin and the complex return flow pattern arising from the Supplemental Water Supply Project alternatives was also enhanced.

The modeling was also modified to incorporate the terms included in the Draft Amendatory Water Service Contract negotiated between Reclamation and EBMUD. Although these terms are draft only, they are considered to be representative of terms that may ultimately be approved by Reclamation and EBMUD.

The most recent PROSIM 99 run of the Folsom South Canal Connection Alternative (Alternative 2 in the 1997 DEIR/EIS) was "post-processed" to estimate the changes in lower American River flows that could be expected under Alternative 4. For Alternatives 5 through 8, a PROSIM 99 model run of EBMUD-only operations with EBMUD deliveries at Node 16 (Fairbairn WTP) was used to represent changes in system operations that could be expected.

PROSIM 99 modeling results are not substantively different from the results that were presented in the 1997 DEIR/EIS based on previous versions of PROSIM.

The presentation of some data, including reservoir storage and statistical distributions, was modified from the 1997 DEIR/EIS based on comments requesting clarification. The hydrologic variables of particular interest for this analysis include Folsom Reservoir storage, lower American River streamflow at Nimbus and intake Site 5, and Sacramento River flows at Freeport.

Note: PROSIM 99 modeling data were provided to the Sacramento parties and others. The data are available on request from EBMUD at (510) 287-1197.

MODELING ASSUMPTIONS

The general process of hydrologic modeling of existing conditions, No Action, and project alternatives with the current version of PROSIM 99 was unchanged from the 1997 DEIR/EIS. The period of record for the hydrologic analysis is the same and consists of the 70-year period of 1922 –1991. The major changes consist of the alternatives considered, which are briefly described below. In addition, the City and County would not participate in any of the supplemental alternatives.

Existing Conditions

Existing conditions represent hydrologic conditions that would be expected without implementation of the project alternatives, future increases in demands by other entities, or changes in flow standards. The hydrologic evaluation of existing conditions is based on the present level of water demands and existing CVP operations (Table 3-1). This level of development is representative of the existing demand for water from the American River and assumes that only currently existing facilities are in place. PROSIM results for existing conditions are not presented because there have not been any substantial changes in water conveyance or storage facilities since publication of the 1997 DEIR/EIS. Therefore, this analysis is focused on comparing proposed project conditions with No Action conditions in similar fashion to the 1997 DEIR/EIS.

Table 3-1. Primary Assumptions Used in the EBMUD PROSIM Modeling [a]

	Water Demand (acre-feet)	
	Existing Conditions (1995)	**Alternative 1: No Action (2030)**
CVP agricultural demands[b]		
North of the Delta[f]	2,547,000	2,546,000
South of the Delta	2,980,000	2,983,000
CVP municipal and industrial demands		
North of the Delta	441,000	551,000
South of the Delta	145,000	145,000
American River demands[c, f]	285,000	368,000
Wildlife refuge demands (Firm Level II)		
North of the Delta	92,000	190,000
South of the Delta	157,000	292,000
Nonproject demands	3,119,000	3,315,000
State Water Project demands	3,998,000	4,222,000
Folsom Reservoir operation	400,000–670,000 flood rule curve	400,000–670,000 flood rule curve
American River instream flows	Modified D-1400	AFRP flows[e]
Dedicated water	not applicable	upstream
Trinity River flows	340,000	390,000–750,000
Delta standards	Bay/Delta Accord	Bay/Delta Accord
Tuolumne River	FERC criteria	FERC 1996 relicense[g]
Stanislaus River	Drought management principles[d]	D-1422, D95-06
Mokelumne River	LMRMP	Settlement Agreement

[a] Demands were estimated by summing the demand time series for the model input. "North of the Delta" includes PROSIM Nodes 1-29 and 50. "South of the Delta" includes Nodes 30-55, excluding 50.

[b] Demands exclude Feather River service area demands at PROSIM Node 11.

[c] Also included in the CVP North-of-the-Delta demands. Developed by averaging the times series input for PROSIM Nodes 14-17.

[d] Drought management principles are Reclamation actions to preserve storage for low-flow conditions.

[e] Estimates of USFWS's Anadramous Fish Restoration Program objectives as developed in the CVPIA Programmatic EIS based on target flows identified by the USFWS in October 1996.

[f] An additional 36,000 acre-feet is assumed to be diverted by Placer County Water Agency upstream of Folsom Reservoir.

[g] Based on Federal Energy Regulatory Commission license number 2299.

Alternative 1: No Action

Under this alternative, hydrologic conditions are representative of a future level of water development (2030) without CVP deliveries being made to EBMUD. This level of development is representative of increased diversions that may occur in the future without the construction and operation of new diversion facilities by any entity. Therefore, although the demands used in this analysis are 2030 water demands, actual deliveries simulated in the hydrologic modeling are limited because no new facilities were assumed. Table 3-1 provides a comparison between existing demands and future demands. Demand for water in 2030 from the American River by individual water purveyors is shown in Table 3-2. Revised PROSIM 99 modeling was conducted for the No Action alternative.

Alternative 4: EBMUD-Only Lower American River Delivery

Under Alternative 4, additional demands were estimated based on PROSIM 99 modeling of Alternative 2 as described in the 1997 DEIR/EIS. Under Alternative 4, EBMUD would take delivery of water under its water service contract from Site 5 on the Lower American River up to the maximum intake capacity of the pipeline (155 cfs). Two delivery scenarios were evaluated for Alternative 4. Scenario 1 assumes that EBMUD deliveries would be subject to Hodge Decision flow criteria. Scenario 2 additionally limits EBMUD deliveries based on project unimpaired inflow as described in Chapter 2 of this REIR/SEIS. The EBMUD demands were added to the hydrologic simulation of Alternative 1 and represent the only change in the modeling from Alternative 1. The assumed operations of this alternative are described in Chapter 2, "Alternatives Considered in the REIR/SEIS."

Alternatives 5, 6, 7, and 8

For Alternatives 5, 6, 7, and 8, PROSIM 99 modeling that assumed EBMUD deliveries from model Node 16 on the American River was used to provide information representative of deliveries from the alternative downstream locations. A single model run was used to represent these alternatives, because Reclamation and EBMUD would operate water supply facilities in an identical fashion for each of these alternatives.

EBMUD deliveries from these downstream locations would be greater than under Alternative 4 because they would not be subject to Hodge Decision flows or limits related to unimpaired runoff in the Lower American River. As described in Chapter 2, "Alternatives Considered in the REIR/SEIS," EBMUD delivery points would differ between these alternatives. The Alternative 5 delivery point is on the Sacramento River immediately downstream of the mouth of the American River. Delivery for Alternatives 6 and 7 is from the same location in the Sacramento River near Freeport. Alternative 8 delivery is from Indian Slough near the Bixler location in the Sacramento–San Joaquin River Delta (Delta). EBMUD would receive delivery of water up to the maximum intake rate of 155 cfs. As under Alternative 4, these are the only demands that were added to the hydrologic simulation of Alternative 1.

Cumulative Evaluation

No additional PROSIM modeling was conducted for the cumulative conditions because EBMUD's relative contribution to hydrologic changes under cumulative conditions would be similar to those described in the 1997 DEIR/EIS under Alternative 3 cumulative conditions.

AFFECTED ENVIRONMENT

The "Affected Environment" section presented in the 1997 DEIR/EIS is essentially unchanged. Therefore, hydrology and water supply conditions in the American and Mokelumne River basins, Sacramento and Feather Rivers, and Delta are only briefly described as they pertain to the specific analyses described for the supplemental alternatives.

Table 3-2. Comparison of American River Demands (acre-feet)

Agency	No Action (Alternative 1)	EBMUD-Only Lower American River Delivery (Alternative 4 – Scenario 1)	EBMUD-Only Lower American River Delivery (Alternative 4 – Scenario 2)	Downstream Delivery (Alternatives 5, 6, 7, and 8)
PROSIM Node 14 [a]				
Placer County Water Agency Water Rights	25,000	25,000	25,000	25,000
Placer County Water Agency	0	0	0	0
Roseville	0	0	0	0
Granite Bay	25,000	25,000	25,000	25,000
Northridge	0	0	0	0
North Area Water Rights	60,000	60,000	60,000	60,000
Fair Oaks	15,000	15,000	15,000	15,000
Citrus Heights	18,000	18,000	18,000	18,000
City of Folsom	20,000	20,000	20,000	20,000
Folsom Prison	2,000	2,000	2,000	2,000
Folsom Transfer	5,000	5,000	5,000	5,000
San Juan Suburban	11,200	11,200	11,200	11,200
Orangevale	6,500	6,500	6,500	6,500
City of Folsom	700	700	700	700
San Juan (County)	4,000	4,000	4,000	4,000
El Dorado Irrigation District	7,550	7,550	7,550	7,550
El Dorado Hills	7,500	7,500	7,500	7,500
El Dorado Irrigation District	50	50	50	50
Georgetown	0	0	0	0
Roseville	26,000	26,000	26,000	26,000
Roseville (CVP)	26,000	26,000	26,000	26,000
Placer County Water Agency (CVP)	0	0	0	0
Total	**129,800**	**129,800**	**129,800**	**129,800**
PROSIM Node 15				
Southern California Water Company	5,000	5,000	5,000	5,000
Sacramento Municipal Utilities District	15,000	15,000	15,000	15,000
EBMUD	0	0	0	0
Losses	5,000	5,000	5,000	5,000
California Parks and Recreation	5,000	5,000	5,000	5,000
Sacramento County	15,000	15,000	15,000	15,000
Total	**45,000**	**45,000**	**45,000**	**45,000**
PROSIM Node 16				
City of Sacramento	100,000	100,000	100,000	100,000
EBMUD	0	15,100[b]	11,200[b]	21,300[b]
Sacramento County	0	0	0	0
Carmichael	12,000	12,000	12,000	12,000
Total	**112,000**	**127,100**	**123,200**	**133,300**
PROSIM Node 17				
City of Sacramento	81,200	81,200	81,200	81,200
Total	**81,200**	**81,200**	**81,200**	**81,200**

[a] An additional 36,000 acre-feet is assumed to be diverted by Placer County Water Agency upstream of Folsom Reservoir.

[b] Average annual delivery through the intake facility based on 155 cfs EBMUD capacity and EBMUD operations.

Hydrology, Water Supply, and Demands

American River Basin

The hydrology and operating conditions for flood control and water supply storage in Folsom Reservoir and lower American River flow releases are largely unchanged since publication of the 1997 DEIR/EIS. Reclamation has operated Folsom Dam to attempt to meet flows that the USFWS's Anadromous Fish Restoration Program (AFRP) has recommended as part of the CVPIA. Currently, these flows are specified annually by USFWS. The Water Forum has suggested modified AFRP storage-flow criteria that emphasize summer flows for temperature protection of steelhead.

American River Demands

Projected water supply demands from the American River basin have not changed substantially since publication of the 1997 DEIR/EIS.

Mokelumne River Basin

There have been no changes in water supply or EBMUD operations of water supply storage and delivery patterns from the Mokelumne River basin since the publication of the 1997 DEIR/EIS.

Sacramento–San Joaquin River Delta

Demands for municipal water supplies, agriculture, recreation, and instream flows in the Delta are changing as growth occurs and regulatory conditions are modified through endangered species protection measures. There have been no major changes in basin demands since publication of the 1997 DEIR/EIS.

Implementation of other laws, such as the CVPIA and CALFED program, will also serve to change water supply management in the future. Since the publication of the 1997 DEIR/EIS, the CALFED process has progressed to developing policies and strategies for protecting the Delta environment and enhancing water supply reliability of state and federal facilities.

Implementation of CALFED programs is a long-term process. For purposes of this project evaluation, the water supply demands, instream flow requirements, and applicable Delta water quality objectives are assumed to remain unchanged.

EBMUD American River Deliveries (Alternative 4)

Projected deliveries from the American River to EBMUD under Alternative 4 were estimated for both scenarios by processing existing PROSIM 99 modeling data for Alternative 2 as described in the 1997 DEIR/EIS (Figure 3-1). Under Alternative 4 conditions, EBMUD deliveries would occur in a majority of the 70 years evaluated under both Scenario 1 and Scenario 2. The monthly frequency of deliveries from the American River is high and similar to that presented in the 1997 DEIR/EIS. However, EBMUD's average annual take under Scenario 1 would be 15,100 acre-feet, which is about 14,000 acre-feet lower than EBMUD's yield from the Folsom South Canal Connection alternative evaluated in the 1997 DEIR/EIS. A maximum take of 56,400 acre-feet was projected in year 1963. During the 1928–1934 dry-year period, the annual average EBMUD deliveries would be 14,000 acre-feet.

EBMUD annual average delivery for Scenario 2 would be 11,200 acre-feet, which is approximately 18,000 acre-feet less than for the Folsom South Canal Connection alternative evaluated in the 1997 DEIR/EIS. A maximum delivery of 46,000 acre-feet was projected in year 1954, and the average delivery during the 1928–1934 dry-year period would be 10,200 acre-feet.

Under both scenarios, a portion of the decreased deliveries to EBMUD are a result of the revisions that were made to PROSIM 99 as compared to the version of PROSIM that was used in the 1997 DEIR/EIS.

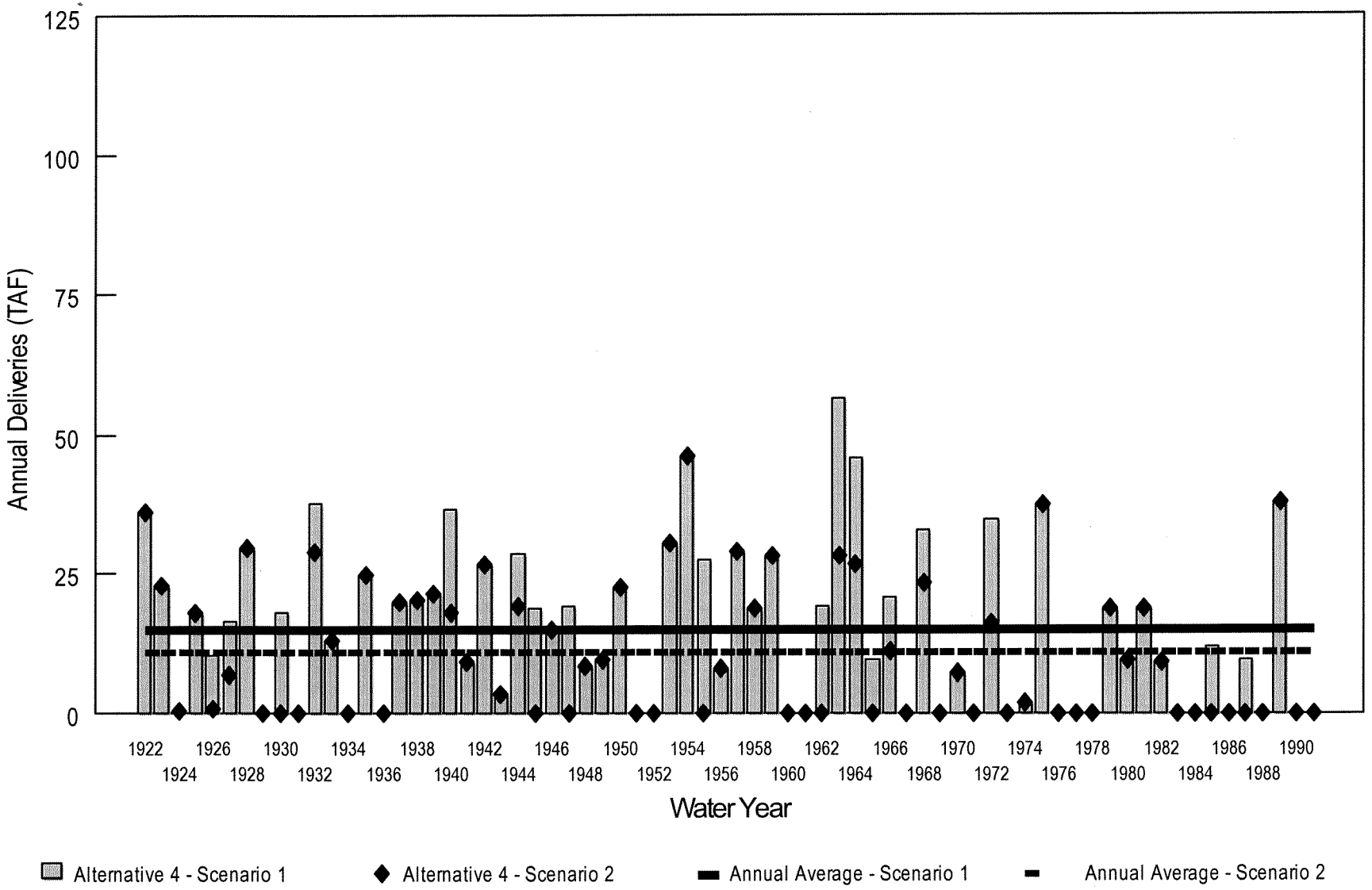


Figure 3-1.
Annual Deliveries for Alternative 4 Scenario 1 and Scenario 2

EBMUD Deliveries from the Sacramento River and Delta (Alternatives 5, 6, 7, and 8)

Deliveries to EBMUD from the Sacramento River under Alternatives 5, 6, and 7, and from the Delta under Alternative 8, were simulated with the current PROSIM model and are shown in Figure 3-2. Although the delivery location would differ between the alternatives, the schedule and average annual delivery is assumed to be essentially the same, because upstream reservoir operations would be similar in order to satisfy demand.

Annual average EBMUD deliveries for these supplemental alternatives would be 21,300 acre-feet, which is 13,300 acre-feet less than the EBMUD deliveries in the 1997 DEIR/EIS joint project (Alternative 3). This difference is a result of changes in the PROSIM model since publication of the 1997 DEIR/EIS and, more importantly, incorporation of the draft Amendatory Contract terms into the modeling.

A maximum delivery of 99,300 acre-feet was projected in year 1988, and the average delivery during the 1928–1934 dry-year period would be 42,500 acre-feet. Without restrictions for Hodge flow and unimpaired runoff in the American River, EBMUD's delivery would be larger during dry years. Most of the deliveries would occur during March through September.

RESULTS

Hydrologic Conditions

As described in the 1997 DEIR/EIS, changes in hydrologic characteristics resulting from increased deliveries made from the American River do not necessarily constitute an environmental impact. However, changes in hydrologic regimes can affect resources such as fisheries, water quality, vegetation, recreation, and visual characteristics of rivers and reservoirs.

Folsom Reservoir

Figure 3-3 shows Folsom monthly storage and distribution of carryover storage for Alternative 4, Scenario 1, and Alternative 1, "No Action," with the current version of PROSIM. The data indicate that project-related EBMUD deliveries would negligibly affect Folsom Reservoir storage. Under Alternative 4, Scenario 1, annual average carryover storage would be 5,000 acre-feet lower than under Alternative 1. Carryover storage for the 1928–1934 dry period would be approximately 3,200 acre-feet lower than Alternative 1. Because EBMUD deliveries would be further limited under Scenario 2, effects on Folsom Reservoir storage would be reduced.

Figure 3-4 shows Folsom monthly storage and distribution of carryover storage for Alternatives 5 through 8 and Alternative 1 with the current version of PROSIM. The data indicate that project-related EBMUD deliveries would negligibly affect Folsom Reservoir storage. Table 3-3 shows a summary of average monthly and annual changes in Folsom storage values for the supplemental alternatives and Alternative 1. Under Alternatives 5, 6, 7, and 8, the monthly reductions in Folsom storage are not as large as under Alternative 4. Additionally, with EBMUD deliveries made downstream for Alternatives 5, 6, 7, and 8, Reclamation would have somewhat greater flexibility to supply water in response to EBMUD demands from either Folsom or Shasta storage. The annual average Folsom carryover storage would be 2,900 acre-feet lower than Alternative 1. However, because deliveries under these alternatives would occur primarily during dry years, carryover storage for the 1928–1934 dry period would be approximately 9,400 acre-feet lower than under Alternative 1. Because the downstream delivery locations for Alternatives 5, 6, 7, and 8 are simulated at PROSIM Node 16 on the American River, rather than on the Sacramento River or in the Delta, these simulated effects on Folsom storage may be high.

Alternatives 5, 6, 7, and 8 represent the highest yield of EBMUD deliveries among the supplemental alternatives. Table 3-4 shows the difference in hydrologic conditions between Alternatives 5, 6, 7, and 8 and the respective Alternative 1 values.

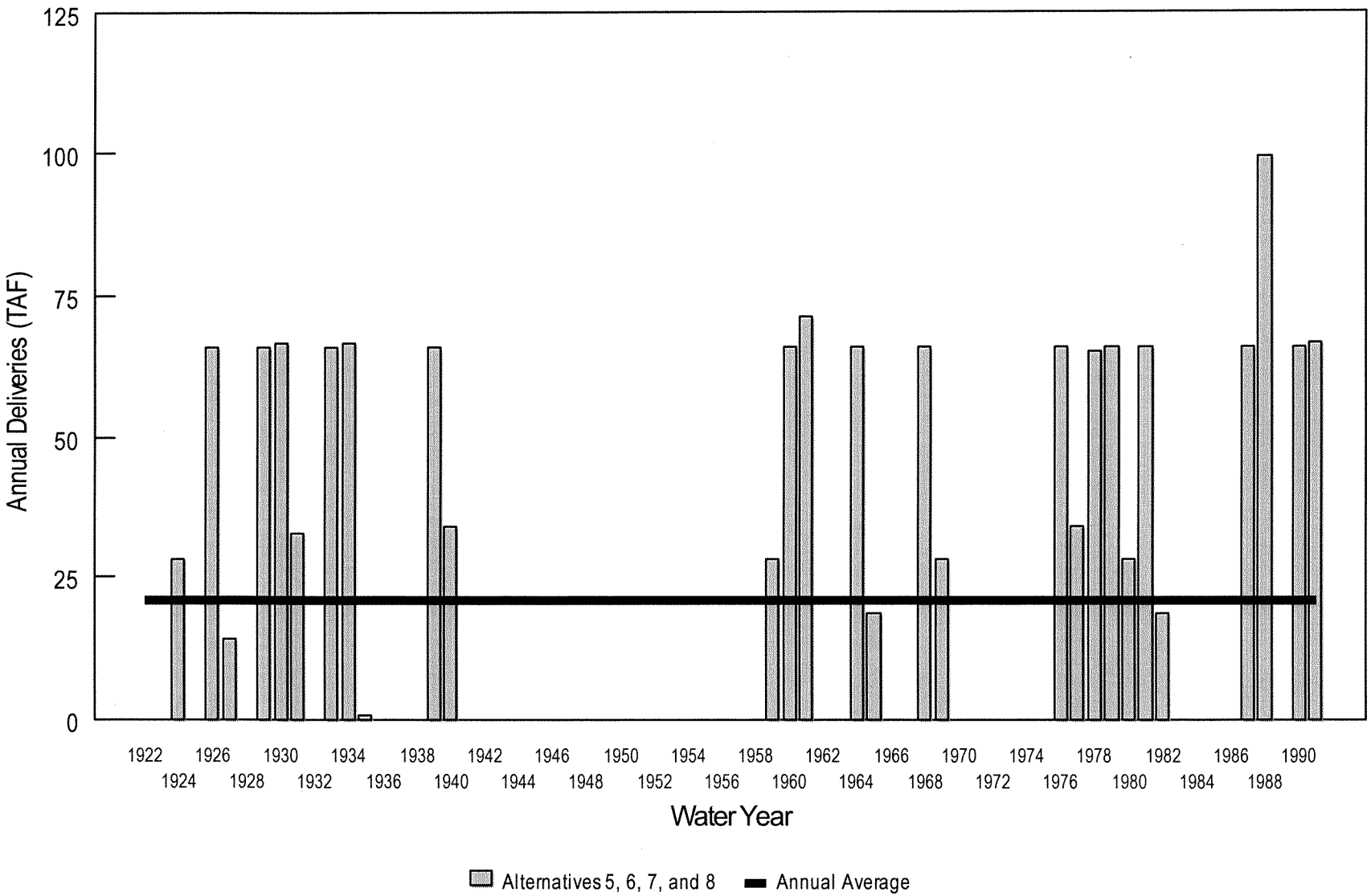


Figure 3-2.
Annual Deliveries for Alternatives 5, 6, 7, and 8

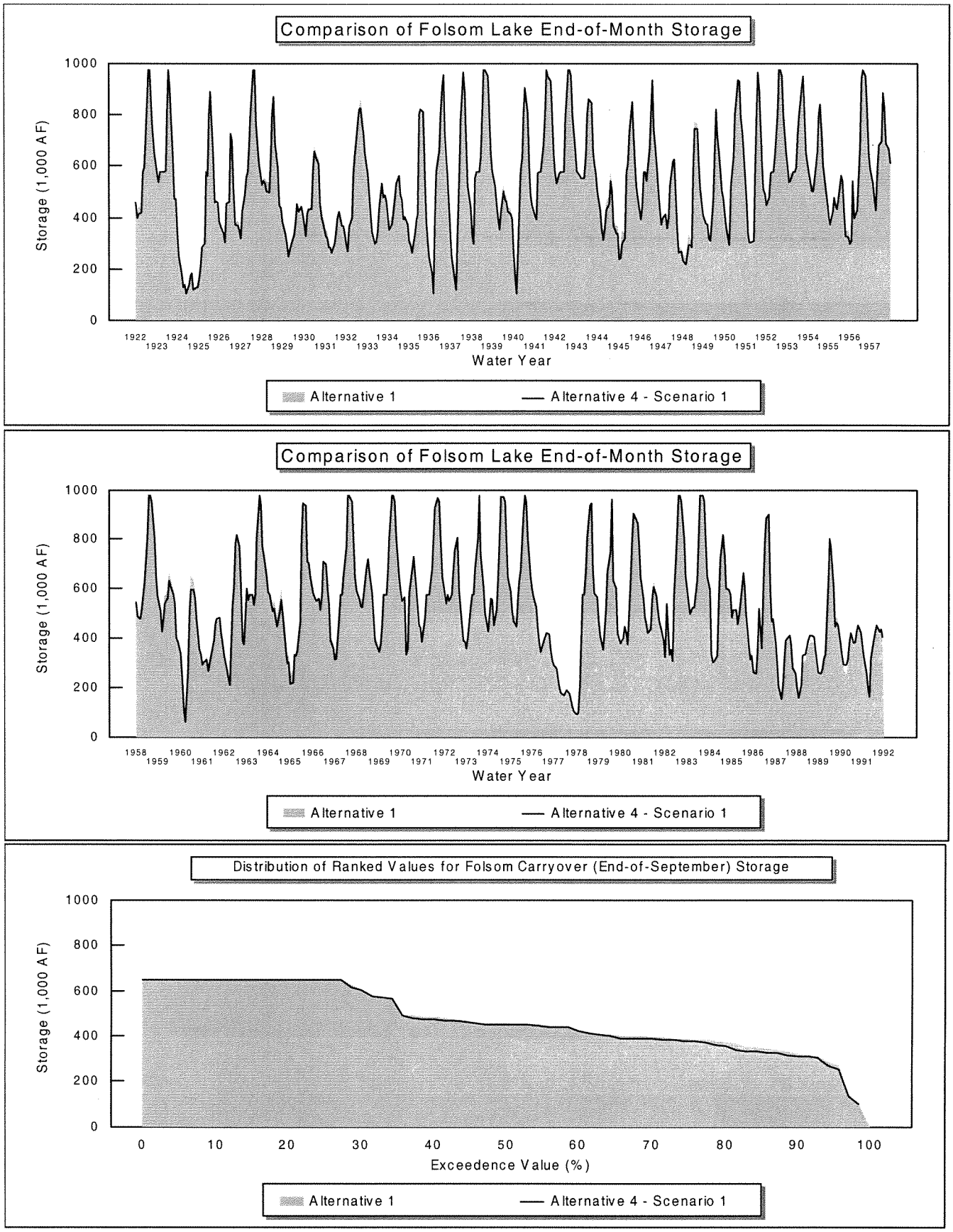


Figure 3-3.
Folsom Lake Storage:
Alternative 4 and Alternative 1

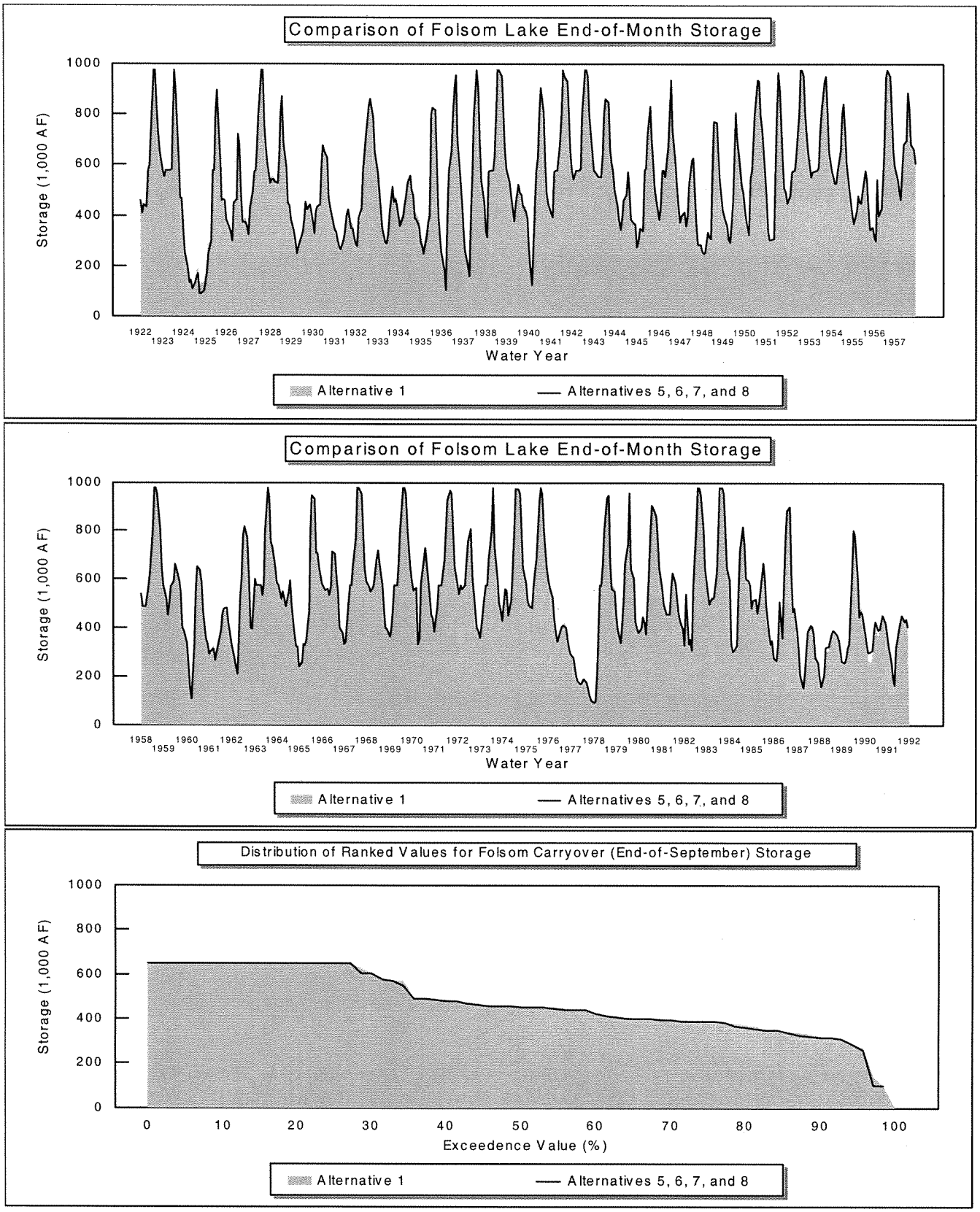


Figure 3-4.
Folsom Lake Storage:
Alternatives 5, 6, 7, 8, and Alternative 1

Table 3-3. Summary of Average Differences in Hydrologic Characteristics as Compared with Alternative 1 for Selected Locations

Location and Alternative Scenarios	Month of Water Year												Annual Average Value (TAF)
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
Folsom Storage (TAF)													
Alternative 4 (Scenario 1) minus Alternative 1	-5	-8	-9	-8	-5	-4	-4	-3	-2	-3	-6	-5	-5
Alternatives 5, 6, 7, and 8 minus Alternative 1	-3	-2	-1	0	0	0	0	0	-1	-3	-3	-3	-1
American River flow below Nimbus (cfs)													
Alternative 4 (Scenario 1) minus Alternative 1	1	37	1	-45	-67	-13	-20	-11	-26	5	15	-30	-9
Alternatives 5, 6, 7, and 8 minus Alternative 1	-6	-4	-17	-16	-1	-5	-4	0	20	31	11	-8	0
American River flow below Site 5 (cfs) (Note 1)													
Alternative 4 (Scenario 1) minus Alternative 1	1	37	1	-45	-99	-13	-20	-12	-26	5	15	-30	-11
Sacramento River flow below Freeport (cfs) (Note 2)													
Alternative 4 (Scenario 1) minus Alternative 1	10	-31	-71	-78	-368	-38	-54	-18	-12	40	-3	-4	-37
Alternatives 5, 6, and 7 minus Alternative 1	-29	-51	-38	-39	-17	-18	-34	-13	3	-12	-7	-34	-17

Notes: (1) EBMUD delivery modeled from PROSIM Node 16 on American River; therefore, Site 5 flows for delivery alternatives downstream of the American River (Alternatives 5 through 8) were not calculated.

(2) EBMUD delivery modeled from PROSIM Node 16 on American River; therefore, Freeport flows for delivery near Bixler Island in the Delta (Alternative 8) were not calculated.

cfs = cubic feet per second
TAF = 1,000 acre feet

Table 3-4. Difference in Hydrologic Conditions Between Alternative 1 and Alternatives 5, 6, 7, and 8

Location and Alternative Scenarios	Month of Water Year												Annual Average Value (TAF)
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
Folsom Storage (TAF)	-3	-2	-1	0	0	0	0	0	-1	-3	-3	-3	-1
Nimbus Flow (cfs)	-6	-4	-17	-16	-1	-5	-4	0	20	31	11	-8	0
Freeport Flow (cfs)	-29	-51	-38	-39	-17	-18	-34	-13	3	-12	-7	-34	-17
Shasta Storage (TAF)	-7	-5	-3	-3	-2	-5	-5	-7	-9	-8	-9	-8	-6
Trinity Storage (TAF)	-3	-3	-4	-3	-3	-3	-3	-3	-1	-2	-2	-2	-3
Delta Outflow (cfs)	8	5	29	-18	-32	-21	-20	0	2	-8	-1	-16	-4
Banks Export (cfs)	-21	-15	0	-7	56	0	-5	-2	-3	3	-8	-5	0
Tracy Export (cfs)	-3	-34	-3	0	16	36	-5	2	8	-7	2	-12	0

Notes: cfs = cubic feet per second
TAF = 1,000 acre feet

Lower American River

Effects of the project alternatives were evaluated for flows in the lower American River below Nimbus Dam. Figure 3-5 shows the 70-year flow record and distribution of ranked data for flows below Nimbus Dam for Alternative 4. Deliveries made under Scenario 1 would result in negligible changes in flow because deliveries generally occur when river flows greatly exceed minimum instream flow requirements. Because deliveries to EBMUD would be even more limited under Scenario 2, effects on flows would be reduced as compared to Scenario 1.

Table 3-3 shows the differences in hydrologic conditions, as compared with Alternative 1, at selected locations below Nimbus Dam. The data indicate that the average annual volume of flow below Site 5 is reduced by 11,000 acre-feet under Scenario 1 compared to Alternative 1. Results do not change appreciably in the 1928–1934 dry period, with a reduction in mean annual flow of 14,000 acre-feet under Scenario 1.

The monthly and annual total flow downstream from Nimbus (Table 3-3) would not change appreciably under Alternatives 5, 6, 7, or 8. As described above, Reclamation would have flexibility to release water from either Folsom or Shasta in response to EBMUD demands. Any changes in flow would generally extend the full length of the American River to the confluence with the Sacramento River and the alternative EBMUD delivery locations.

The relative change between Alternatives 5, 6, 7, and 8 and Alternative 1 conditions for flows below Nimbus are shown in Table 3-4 and Figure 3-6. The data indicate that total flow volume would not change under Alternatives 5, 6, 7, or 8.

Sacramento River at Freeport

Effects of the project alternatives were evaluated for flows in the Sacramento River below the proposed intake structures. Figure 3-7 shows the 70-year flow record and distribution of ranked data for flows below Freeport under Alternative 4. Changes in flow between the current version of PROSIM and that used in the 1997 DEIR/EIS are essentially undetectable. Deliveries made under Scenario 1 would result in negligible changes in flow because the magnitudes of EBMUD deliveries are extremely small compared to background flow values. Table 3-3 indicates that the average annual volume of flow at Freeport is reduced by 37,000 acre-feet under Scenario 1 compared to Alternative 1. The fact that PROSIM reports larger changes in flow volume than can be accounted for by average annual EBMUD deliveries indicates that the model may be overly sensitive to relatively small changes in water supply demands.

For Alternatives 5, 6, and 7, Table 3-4 and Figure 3-8 show the average annual reduction in flow at Freeport compared to Alternative 1. For Alternative 8, EBMUD delivery at Bixler in the Delta was not specifically modeled. Therefore, the anticipated changes in flows at Freeport can only be assessed qualitatively. Flows at Freeport under Alternative 8 would generally be higher than under the other supplemental alternatives during the dry months of the year, because flow would remain in the channel and be conveyed to the Delta, where EBMUD would take delivery. The effect of Alternative 8 on Delta outflow would be expected to be the same as under Alternatives 5, 6, and 7.

Hydrologic Changes to Other Reservoirs, Delta Exports, and Delta Outflow

Table 3-4 shows relative differences between Alternatives 5, 6, 7, and 8 and the respective Alternative 1 values for Shasta Reservoir storage, Clair Engle Reservoir storage on the Trinity River, Delta outflow, and Delta exports at Tracy and Banks pumping plants.

In general, the current PROSIM results are very similar to the data presented in the 1997 DEIR/EIS.

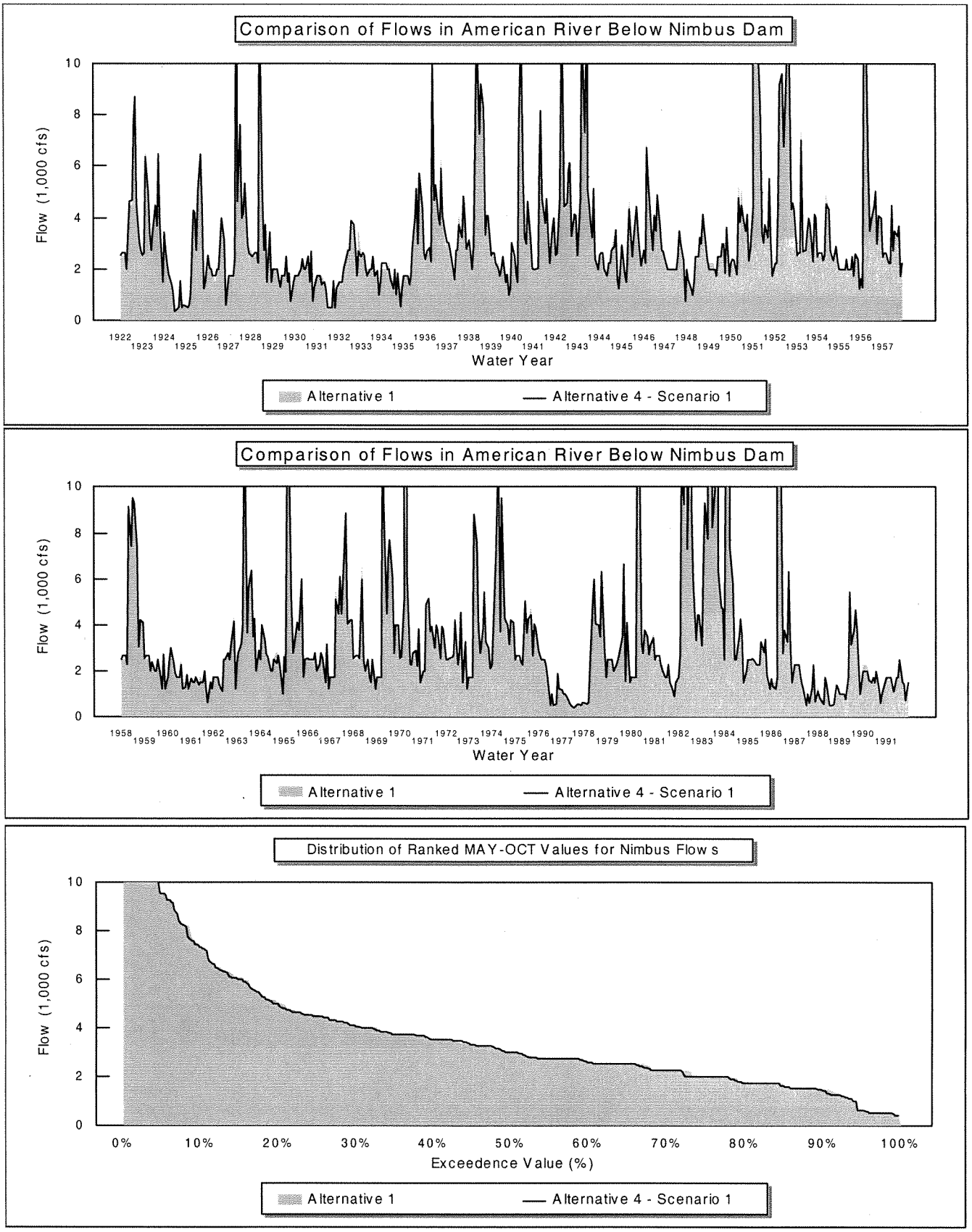
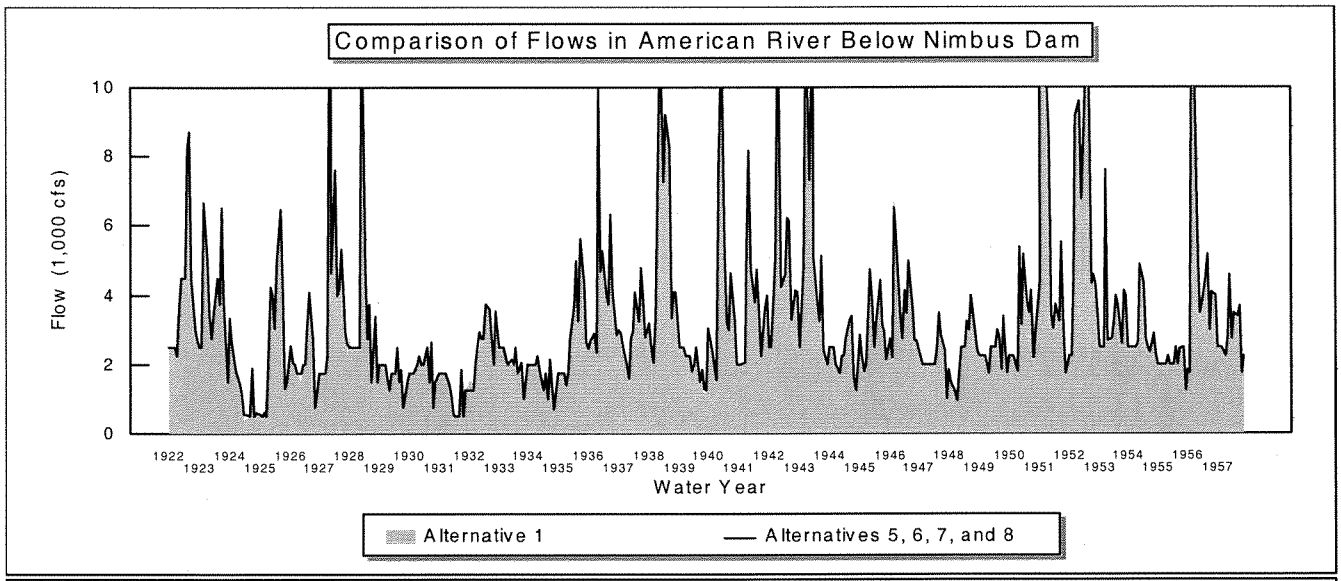
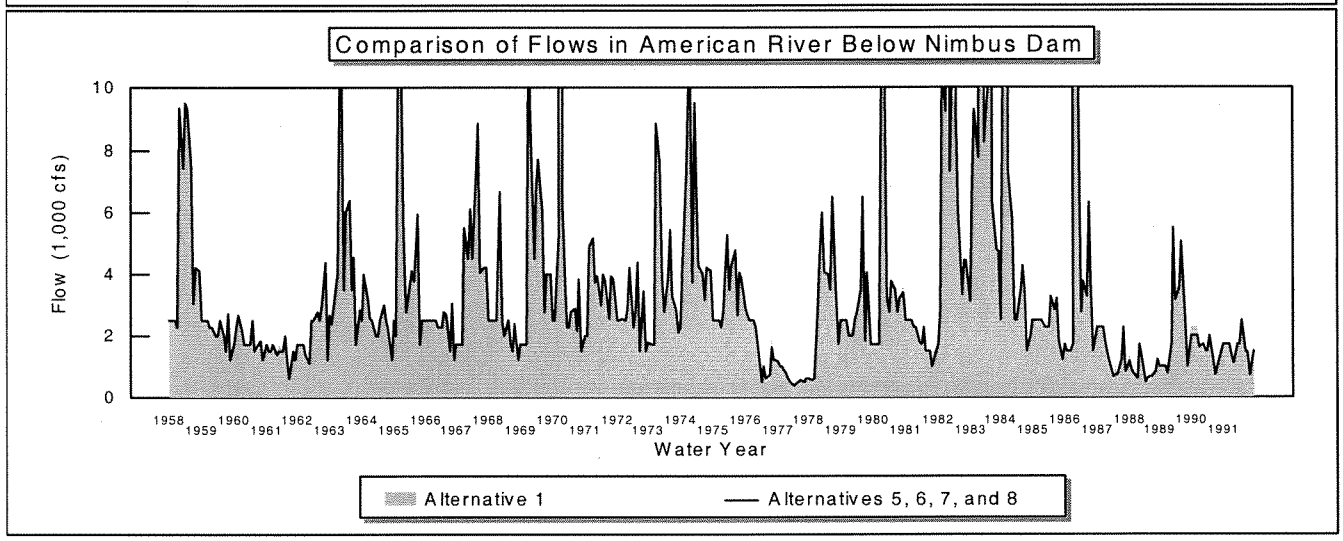


Figure 3-5.
American River Flows Below Nimbus Dam:
Alternative 4 and Alternative 1





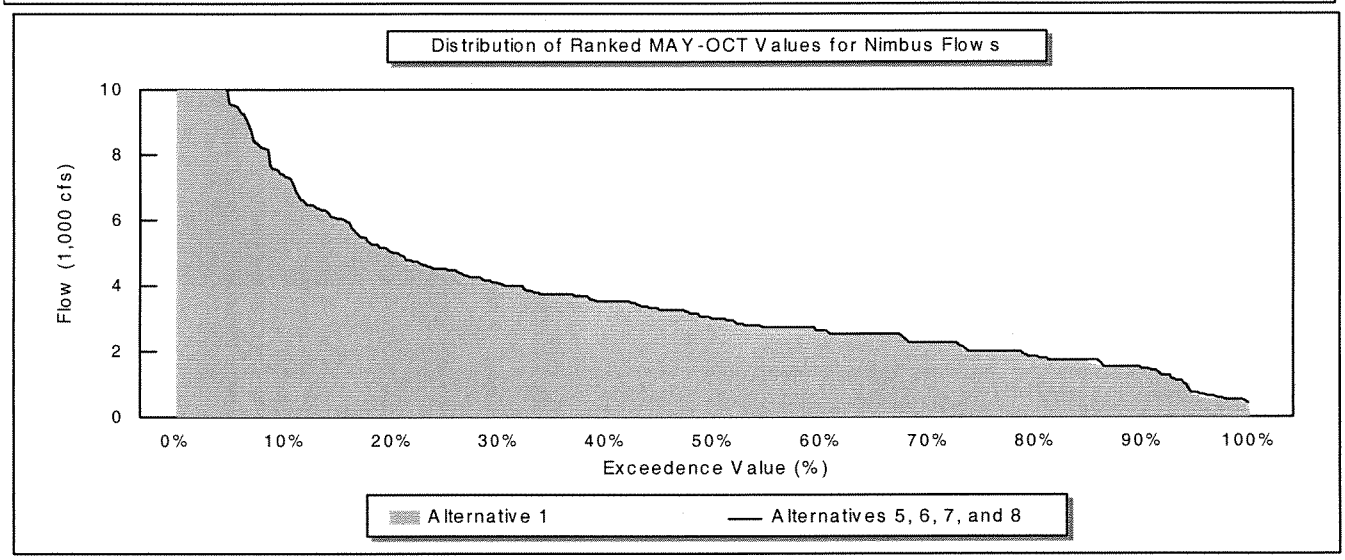


Figure 3-6.
American River Flows Below Nimbus Dam:
Alternatives 5, 6, 7, 8, and Alternative 1

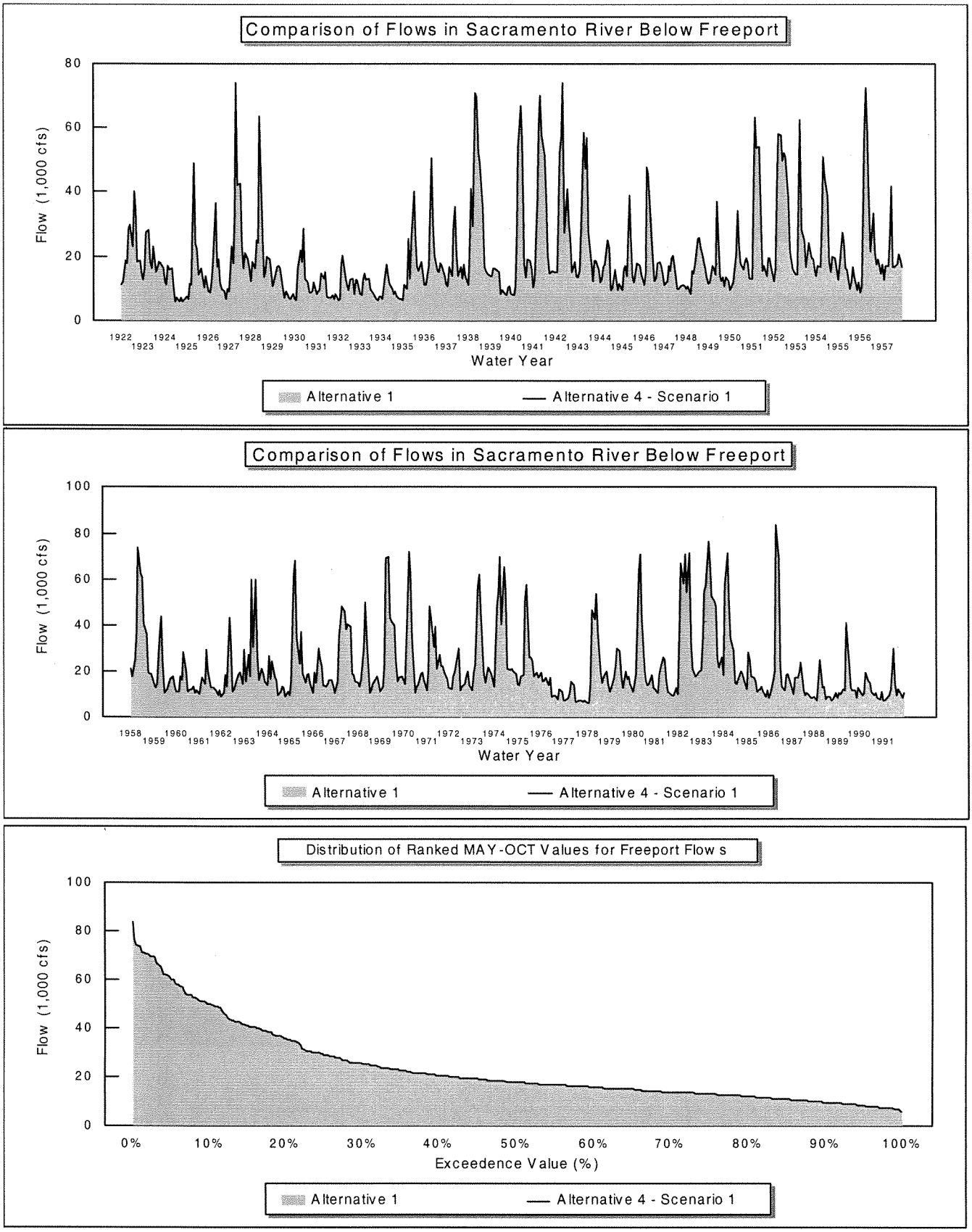


Figure 3-7.
American River Flows Below Freeport:
Alternative 4 and Alternative 1

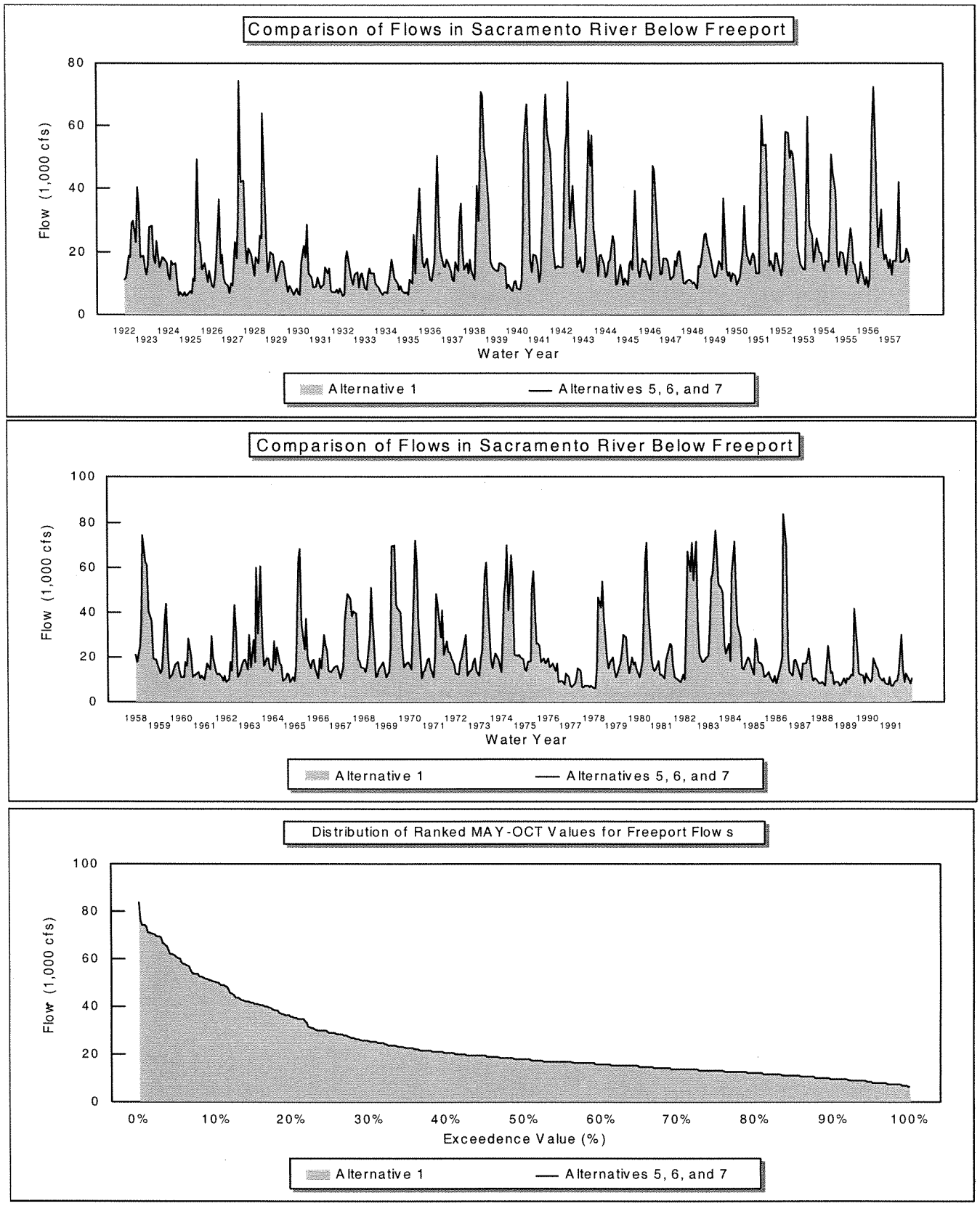


Figure 3-8.
American River Flows Below Freeport:
Alternatives 5, 6, 7, 8, and Alternative 1